

## Transplanting Giant Kelp (*Macrocystis pyrifera*) onto Artificial Reefs: The San Clemente Reef Mitigation Project

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Southern California Edison Co. (SCE) is required to build a 300 hectare (150 acre) artificial reef for the purpose of mitigating the impacts of the San Onofre Nuclear Generating Station on nearby kelp bed communities. One of the primary mitigation requirements is that the reef supports a stable population of moderate to high density of giant kelp (*Macrocystis pyrifera*). As an initial step in reef development, SCE constructed an experimental reef in fall 1999 to test several reef designs that are being considered for the larger mitigation effort (Deysher et al. 1998, in press). The experimental reef consists of 56 modules, each measuring approximately 40 × 40 m, which were placed on a sandy bottom at depths of 12 to 15 m off San Clemente, CA. Half the modules were constructed of quarry rock, the other half were constructed of waste concrete, and all were low relief (less than 1 m). In summer 2000, we transplanted juvenile giant kelp (*M. pyrifera*) onto 14 of these modules (seven quarry-rock and seven concrete) to test transplanting as a potential means of enhancing and maintaining moderate to high densities of kelp. In this paper we describe the diving techniques used in anchoring these plants onto concrete or rocks.

The kelp used in transplanting were initially reared in the laboratory using methods described in Foster et al. (1985) and then transplanted onto the reefs. Divers collected sporophylls (spore-bearing blades) from the base of adult kelp and brought these back to the laboratory. There, we released spores from the blades and inoculated 0.6 cm diameter × 10 cm long nylon lines with the spore solution. The lines were cultured in the laboratory for about three to five weeks until a dense culture of small kelp plants (about 1 mm to 5 mm in height) was visible. The lines were then taken to reef sites and anchored onto rocks or concrete.

The anchoring systems used to attach cultured lines to the rocks were put out in fall 1999 and winter 2000, shortly after the reef modules were installed. These were made of rectangular plastic plates measuring 10 cm × 2.5 cm × 0.7 cm. Two plastic cable ties were strung through holes in the plastic so that lines with small kelp plants could be attached to the plate. The plates were attached to the rocks or concrete as follows. First, one diver drilled holes in the rocks using a pneumatic drill run off of a compressor on the boat. A second diver followed and attached the plastic plates. A commercially available stainless steel anchor bolt with a nylon expansion sleeve was placed through a hole drilled into the plate and the bolt was hammered into the hole in the rock or concrete. Plastic tags were placed on the plates so that they could be more easily located when we were ready to transplant the kelp. A total of 60 anchors were placed on each reef module. The modules were placed along two permanent lead core transect lines stretched the length of the reef module and spaced about 15 m apart. Anchors were placed about 1 m on either side of the transect line at about 2.5 m intervals along the line.

Laboratory cultures were initiated in spring 2000, and transplanting was begun in June of that year. We took the lines with small plants from the laboratory culture, and divers placed one line on each of the anchors. Prior to entering the water, divers transferred lines onto small wooden racks (approximately 30 cm × 4 cm × 1 cm). Each rack had a strip of Velcro™ attached and was fitted with a short piece of fishing line and a small fishing weight. The nylon lines with plants attached were secured to Velcro™. This provided divers with a holder that could be placed on the bottom to free both hands for transplanting. The racks kept the lines with plants attached from being swept away by surge or being abraded by contact with the bottom, yet made pieces of line easy for divers to remove during the transplanting process.

On average, each diver was able to transplant 15 plants on a single dive of approximately 40 minutes. Conditions during the transplanting were often less than optimal, with visibility less than 2 m and moderate to strong surge. This made the process of locating anchors somewhat difficult at times, even though the anchors were tagged and laid out along transect lines. Once divers located anchors, they were able to quickly place the line with small kelp onto holders and then cinch down the cable ties.

The transplanting effort was completed in July 2000. A survey of the reefs in September and October 2000 indicated that approximately 90% of the lines that were put out had surviving plants on them, and most had at least one plant that was 40 cm or larger. By November of that year, many of the transplants were nearly a meter tall and had holdfasts (root-like structures) that had grown over the anchor plates and were attached to the rock or concrete. Surveys are continuing in order to track the growth and survival of these plants.

## References

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